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FUNDAMENTALS FOR THE DESIGN OF OIL MIST LUBRICATION SYSTEMS, PART 3

S. Pytko and K. Bednarek

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16. Abstract

Formulae are given for calculating the rate at which oil mist must be supplied to sleeve bearings, sliding surfaces (carriages, rails), spur and worm gears, cams, chain gears, and chain conveyors. Guidelines are presented for determining feed-nozzle configurations, venting systems, and lubrication groove patterns.

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FUNDAMENTALS FOR THE DESIGN OF OIL MIST LUBRICATION SYSTEMS, PART 3

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3. Sleeve Bearings: Quantity of oil mist; selection and arrangement of feed nozzles; venting; lubrication grooves /72*

3.1. Determining the Quantity of Oil Mist

The quantity of oil mist which must be fed to a sleeve bearing to lubricate it is a function of journal diameter, bearing length and bearing operating conditions. It can be determined with the aid of the following formulae:

a) Bearing under medium operating conditions:

$$Q = d \cdot l / 0.22$$

b) Bearing under severe operating conditions:

$$Q = d \cdot l / 0.133$$

c) Bearing under severe operating conditions with high oil losses:

$$Q = d \cdot l / 0.065$$

where Q = quantity of oil mist in dm^3/min
d = journal diameter in dm
l = bearing length in dm.

For bearings with a journal diameter greater than 125 mm and a bearing length greater than 150 mm, the quantity of oil mist can be determined with the aid of the following formula:

. . . . . .

*Numbers in the margin indicate pagination in the foreign text.

$$Q = 60d \cdot l \cdot S/T$$

where S = bearing tolerance in mm

T = time in hours (from 1 to 4 h) for complete oil exchange in bearing (function of loading).

The category of bearings operating under medium conditions includes:

1. Rotary bearings on horizontal shafts in which the load zone is always located in the lower portion of the bearing.

2. Bearings which are mounted on shafts oriented in any direction and are equipped with ringsseals which prevent the oil from running out of the bearings.

3. Bearings whose boxes are made of porous bronze with sleeves of low-friction synthetic materials.

The category of bearings with severe operating conditions includes:

1. Bearings with oscillating motion on horizontal shafts in which the load zone is always located in the lower half of the bearing.

2. Bearings without ring seals which are subjected to impact forces. The load zone frequentlychanges in these bearings.

3. Bearings of small dimensions in nonhorizontal configurations.

The category of bearings operating under severe conditions with high oil losses includes: /73

1. Bearings with high-frequency rotary or reciprocating motion in which the load zone shifts 180° but tangential velocity does not exceed 3 m/s.

2. Bearings of large dimensions without ring seals in nonhorizontal positions.

3.1.1. Example

Calculate the quantity of oil mist needed to lubricate a bearing operating under severe conditions (Fig. 18):

$$Q = 0.75 \cdot 0.75 / 0.133 = 4.23$$

It is necessary to supply oil mist at 4.23 dm^3/min.

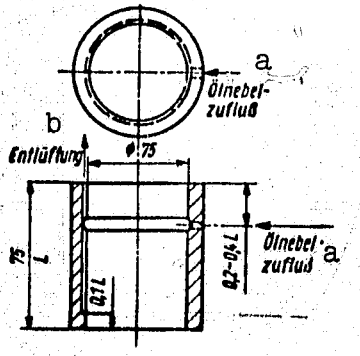

Fig. 18. Arrangement of lubrication grooves and feed nozzle for a sleeve bearing oriented vertically, under severe operating conditions.

Key: a. Oil mist input
b. Vent

3.1.2. Example

Determine the quantity of oil mist for lubricating the bearing shown in Fig. 19, operating under medium conditions:

$$Q = 0.875 \cdot 1 / 0.22 = 3.98$$

It is necessary to supply oil mist at 3.98 dm^3/min.

3.1.3. Example

Determine the quantity of oil mist for lubricating the bearing shown in Fig. 20, operating under severe conditions with possible high oil losses:

$$Q = 1 \cdot 1.25 / 0.065 = 19.2$$

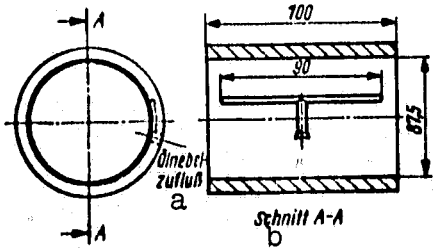

Fig. 19. Arrangement of lubrication grooves and feed nozzle for a sleeve bearing oriented horizontally, under medium operating conditions.

Key: a. Oil mist input
b. Section

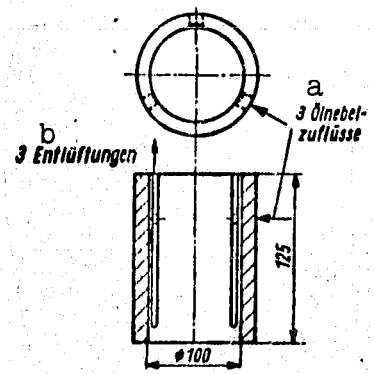

Fig. 20. Arrangement of lubrication grooves and feed nozzles for a sleeve bearing oriented vertically, under severe operating conditions, with heavy oil losses.

Key: a. Three oil mist inputs
b. Three vents

It is necessary to supply oil mist at 19.2 dm^3/min.

3.2. Selection and Arrangement of Feed Nozzles

The use of dripping feed nozzles is recommended for undivided sleeve bearings. In sleeve bearings with divided bearing sleeves, spray feed nozzles, dripping feed or dripping spray nozzles can be used. Dripping feed nozzles must be installed in such a manner that the opening of the nozzle is located over the lubricating groove.

One feed nozzle is provided per 125 mm bearing length (Figs. 21 and 22).

3.3. Lubricating Grooves

When lubricating grooves are machined in sleeve bearings lubricated with oil mist, it is necessary to observe the following generally applicable principles:

1. The lubricating grooves must be designed so that 90% of the opposing surface without grooves (usually that of the journal) can come in /74

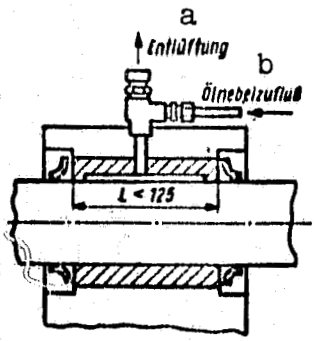

Fig. 21. Arrangement of feed nozzles and vent for sleeve bearing shorter than 125 mm.

Key: a. Evacuation
b. Oil mist input

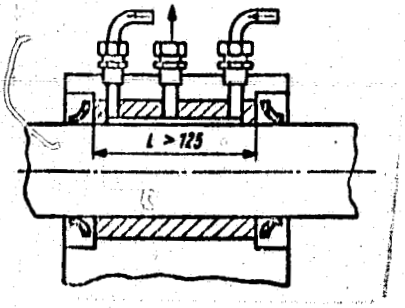

Fig. 22. Arrangement of feed nozzles and vent for sleeve bearing longer than 125 mm.

contact with the lubricating groove during each rotation or reciprocating movement. This condition is frequently satisfied only if a lubricating groove is machined longitudinally in the bearing sleeve whose length amounts to 90% of the bearing's length (see Fig. 19).

To satisfy this condition in bearings subjected to oscillating loads, it may be necessary to machine in several longitudinal grooves and openings (Fig. 20). In bearings with small dimensions, the longitudinal grooves may be connected by a peripheral auxiliary groove. In this way it is possible to feed the lubricant to several longitudinal grooves with the aid of a dripping feed nozzle. In large bearings, however, a separate spray feed nozzle must be installed for each longitudinal lubricating groove.

2. The capacity of each lubricating groove should be as small as possible. If oil input is continuous, it is not necessary to produce lubricating grooves with a large capacity and an oil reserve.

3. Lubricating grooves must be located outside the pressure zone. In bearings with large dimensions, the lubricating grooves must be machined in close to the load zone.

3.4. Venting

The basic principles of sleeve bearing venting are as follows:

1. The lubrication grooves are also used for venting the bearings. For this purpose, it is necessary to bring the longitudinal lubricating grooves in horizontal bearings to 6 mm from the end of the bearings. In vertical bearings, on the other hand, the lubrication grooves, like the feed nozzles, must be placed in the upper portion at a distance of one third of the length of the bearing (Fig. 18). In vertical bearings which do not have peripheral lubricating grooves, all longitudinal openings must be extended to the upper end of the bearing sleeve (Fig. 20).

2. In bearings more than 125 mm long in which no gap exists between the bearing and shaft or which are fitted with ring seals, openings for venting must be drilled in the ends of the lubricating grooves. The feed nozzles can also be installed at the ends of the lubricating grooves, and the venting opening is drilled in the center of the lubricating grooves (Fig. 22).

4. Sliding Surfaces, Carriages and Rails; Quantity of oil mist; type of feed nozzles.

4.1. Calculating the Quantity of Oil Mist

The quantity of oil mist which must be supplied to sliding surfaces, carriages and rails is a function of the contact surface area of the sliding elements and can be determined with the following formulae:

a) Sliding surfaces and carriages:

$$Q = A/1.85$$

b) Rails:

$$Q = A/0.92$$

where Q = quantity of oil mist in dm^3/min
A = contact surface area in dm^2.

4.2. Selection of Feed Nozzles

Dripping feed nozzles or dripping spray nozzles must be used for lubricating sliding surfaces and carriages.

5. Spur and Worm Gears: Quantity of oil mist; type of feed nozzles

5.1. Calculating the Quantity of Oil Mist

The quantity of oil mist which must be supplied to lubricate spur and worm gears is a function of the width and diameter of the gears and can be calculated for a pair of gears with the following formulae:

a) Spur gears:

$$Q = b(d_1 + d_2)/0.305$$

b) Reversible spur gears:

$$Q = b(d_1 + d_2)/0.204$$

c) Worm gears:

$$Q = b(2d_1 + d_2)/0.357$$

d) Reversible worm gears:

$$Q = b(2d_1 + d_2)/0.245$$

where Q = quantity of oil mist in dm^3/min /75

b = gear width in dm

d_1 = pitch diameter of small spur gear or worm in dm

d_2 = pitch diameter of large spur gear or worm wheel in dm.

5.2. Selection of Feed Nozzles

Spray feed nozzles or dripping feed nozzles must be used for lubricating spur gears and worm gears.

6. Cams: Quantity of oil mist; type of feed nozzles

6.1. Determining the Quantity of Oil Mist

The quantity of oil mist which must be fed to a cam is a function of its width and diameter. This quantity can be calculated with the following formula:

$$Q = b \cdot d / 0.9$$

where Q = quantity of oil mist in dm^3/min

b = cam width in dm

d = maximum cam diameter in dm.

6.2. Selection of Feed Nozzles

Spray feed nozzles or dripping feed nozzles must be used for lubricating cams.

7. Chain Gears: Quantity of oil mist; type of feed nozzles

7.1. Determining the Quantity of Oil Mist

The quantity of oil mist which is needed to lubricate a chain gear system is calculated with the following formulae:

a) Roller chain gears:

$$Q = l \, d \, i \, \frac{\sqrt{\left(\frac{n}{100}\right)^3}}{0{,}72}$$

b) Gear system with noiseless chain:

$$Q = b\,d\,\frac{\sqrt{\left(\frac{n}{100}\right)^3}}{1.34}$$

where Q = quantity of oil mist in dm^3/min
l = length of chain wound over wheel in dm
d = pitch diameter of small wheel in dm
i = "chain series number"
b = chain width in dm
n = speed of small sprocket in rpm.

7.2. Selection of Feed Nozzles

Oil mist spray nozzles, spray or dripping spray nozzles must be used for lubricating chain gears, depending, among other things, upon the type of gear housing.

8. Conveyor Chains: Quantity of Oil mist; type of feed nozzles

8.1. Determining the Quantity of Oil Mist

The quantity of oil mist which is used to lubricate conveyor chains is a function of the length and width of the chain and of the diameter of the drive sprocket. It can be determined with the following formula:

$$Q = 3 \cdot d \cdot b \cdot 0.1 \cdot \ell \cdot b / 1.12$$

where Q = quantity of oil mist in dm^3/min
d = pitch diameter of drive sprocket in dm
b = chain width in dm
ℓ = chain length in dm

8.2. Selection of Feed Nozzles

Spray feed nozzles or dripping feed nozzles must be used to lubricate conveyor chains.

(To be continued)